eighty or ninety species of British marine food-fishes are dealt with in their volume.

> "Then (in 1883) the life-history of not a single British marine food-fish was known, at least from observations in our country. In the present work between eighty and ninety species are dealt with, the majority of the important forms more or less exhaustively."

This is obviously an error. From some points of view, it may be convenient to regard every marine fish as a "food-fish." The economic importance of observations on the stickleback is increased if we reckon that pugnacious mite as a "food-fish," and a list of contributions to the solution of practical fishery problems is, by such reckoning, enlarged to imposing dimensions. But in the ordinary sense of the term "food-fish," so many as eighty do not exist in British waters, and only a fractional part of these have any economic importance. The word "exhaustively" is also open to some objection; but as we are given the choice of "more" or "less" in relation to it, we can not actually disagree with the authors' statement.

The preface seems also to me to be deficient in that, whilst the authors there make a profession of acknowledging the sources from which they have gained information, and of recognising the activity of other laboratories and other workers than those to be met with at St. Andrews, yet in the most marked manner all allusion to the Plymouth Laboratory and the publications of the Marine Biological Association is omitted. After making a eulogistic statement as to the importance of the work done at the St. Andrews Marine Laboratory, followed by a list of those who have worked there, the authors at once proceed to say:

> "For many interesting papers connected with the Fisheries we have to thank our fellow-workers in the maritime States of the continent, in America, and the British Colonies."

The suggestion to an uninformed reader is that the only work on these subjects, done elsewhere than "in the maritime States of the continent, in America, and the British Colonies," has been done at St. Andrews. This is very far, indeed, from a truthful suggestion, and is surely due to some oversight on the part of Prof. McIntosh, who has served on the Council of the Marine Biological Association, and is acquainted with the researches carried out on the west coast of Ireland, at Plymouth, in the North Sea, in the Clyde by a host of able investigators remote from his charming little laboratory. Seeing that the authors' book owes a large and important part of its value to the frequent quotations from the *Journal* of the Marine Biological Association, and the work carried on by Mr. Cunningham at the Plymouth Laboratory, and Mr. Holt at Grimsby, it would have been more gracious on their part to have given credit to the Plymouth Laboratory, and the naturalists working in connection with it, when they professed to make acknowledgments to colleagues and predecessors. The work of these investigators, as also of Green, Bateson, Heape and others is made use of, but often without citation of the author's name, and in almost all cases without reference to the original place of publication; so that as a guide to the literature of the subject, the book fails. The index is constructed in a very startling way. One looks up "Cunningham" in order to ascertain how often, and in what terms, his work has been quoted by the authors, and this is what one finds—"Cunningham, J. T., 18, 92, &c." The use of "&c." as a page-reference in an index is altogether new. It does not seem to me to be a real improvement upon the old plan of giving the numbers of the pages to which reference is desired. It is, however, I am sorry to say, indicative of the spirit in which British cotemporary investigators have been treated by Prof. McIntosh and Mr. Masterman.

In a recent review, written by a St. Andrews man, Mr. Cunningham was rebuked for not having referred to Prof. McIntosh and the St. Andrews Laboratory with sufficient frequency in his work on "British Marketable Fishes." It seems that the treatment of the Plymouth Laboratory and *Journal* of the Marine Biological Association and its staff as "&c.," is the retort of St. Andrews. I am sorry, because I have a personal interest in, and regard for both, the Northern and the Southern institution. It is to be hoped that those who have the disposal of fishery appointments at home and abroad will read the productions emanating both from Plymouth and from St. Andrews, so as to be under no illusion as to the non-existence of either. E. RAY LANKESTER.

THE CALCULUS FOR ENGINEERS.

The Calculus for Engineers. By John Perry, F.R.S. Pp. vi + 378. (London and New York: Arnold, 1897.)

HERE is a new departure; a book on the calculus written without any reference to the examination room, solely with the object of teaching the engineer, first that he is already in possession of the fundamental ideas of the calculus, and accustomed to use them, then that these ideas can be easily put into exact mathematical formulæ, and ultimately that the advantages of the formal calculus thus obtained are great indeed, and can be reaped without an enormous amount of previous knowledge.

Prof. Perry does not treat the calculus as something which requires a number of altogether new notions and a great deal of subtle reasoning to be instilled into the mind of the reader. With the instinct of a true teacher, he sets himself to develop notions already in the mind of the learner, and by constant reference to concrete cases leads up to the mathematical ideas of the differential-coefficient and the integral. The former is not defined, as in the ordinary text-books, for any function $y = f(x)$, but the simplest function $y = a + bx$ is considered and plotted out. In fact, Chapter i. begins with the plotting of curves on squared paper, analytical conics or coordinate geometry not being supposed known. It is found that all such equations which have the same value for b have the same *slope*. Hence b is called the slope of the line, and this is denoted by dy/dx. This is followed by exercises on the straight line, familiarising the reader with the notion of slope, and showing how former knowledge of algebra and trigonometry comes in.

Only after this is the differential-coefficient for the simple case treated generally by giving x and y small increments, and therefrom calculating dy/dx. This process of starting with the concrete, and of considering the abstract question only when all ideas involved have been called into life in the student, is altogether to be praised. Thus a sure foundation is laid.

There follows next the example of a train "going at thirty miles an hour." The notion of velocity (why not call it speed ?), and with it that of acceleration, is made mathematically exact. From the law of falling bodies $s = 16{\cdot}1t^2$, the velocity is next deduced. Here the "limiting value" is introduced, and the ordinary process criticised. To quote Prof. Perry :—"Some people have the notion that we are stating something that is only approximately true ; it is often because their teacher will say such things as 'reject $16{\cdot}1\delta t$ because it is small,' or 'let dt be an infinitely small amount of time,' and they proceed to divide something by it, showing that although they may reach the age of Methuselah they will never have the common sense of an engineer." It is the art of taking for granted what the "common sense of an engineer"—that is, of any man who has been obliged to think seriously about the things before him, and not only about how to fill so many sheets of paper in a certain time with answers—instinctively knows to be true, and of leaving out of account all the considerations which superfine criticism of minute and exact abstract considerations introduce, which Prof. Perry's book specially emphasises.

After such preliminaries, interspersed with remarks on many things, such as force and weight, we have the equation $y = ax^2$ in the abstract, and from it dy/dx and d^2y/dx^2 with their integrals and applications to uniformly accelerated motion, the energy of elongated springs, to Ohm's law and to transformers, till at last the case

$$y = ax^n$$

is considered. Here the binomial theorem is supposed to be known in its general form. This assumption is one of the few points where a greater simplification might possibly be introduced by giving a few examples where n is 3, $\frac{1}{2}$, -1 or -2, to show that the formulæ are right. I believe that the learner would have greater faith in the result obtained by seeing it verified in special cases, and this is easy. In the integration of x^n the case $n = -1$ is here *assumed* to give $\log x$, the proof being left to Chapter ii.

At the end of Chapter i. (nearly half the book) there are applications in the most varied form of the simple function x^n ; and "x^n" forms an appropriate heading to the chapter. Partial differentiation is also introduced as a thing only to be mentioned in order to be understood. We are so much accustomed to have most of the simple functions at our disposal from the beginning, that we do not altogether realise how much can be done with the x^n alone. The applications given by Prof Perry are of a most varied kind, very much more so than those in the ordinary text-books, which almost exclusively treat of problems either purely mathematical or geometrical. The first example relates to a perfect steam engine, then come a study of curves, maxima and minima, strength of rectangular beams, electrical problems, areas, volumes, centres of gravity, moments of inertia, curvature, bending, fluid motion and level surfaces, magnetic field, the two elasticities, laws of thermodynamics and entropy, only to mention some of the headings which strike the eye in turning over the pages. Differential equations, ordinary or other, are introduced without hesitation.

It will be seen from this that the course pursued in this book is very different indeed from that of ordinary text-books. The aim is everywhere to go on slowly with the purely mathematical work, but to make the student feel at each step that he has gained actual and useful knowledge which leads at once to important practical applications ; and also to show from the beginning the naturalness of the processes, and to disabuse the beginner of any preconceived idea that the calculus is brimful of difficult and superfine abstractions.

The second chapter contains the compound interest law and the harmonic function ; it is headed "e^x and $\sin x$." The exponential theorem is assumed to be known. This is followed by a new series of applications, including Newton's law of cooling, slipping of a belt over a pulley, and so on ; and some problems are studied of a body vibrating, introducing both forced vibrations and damping. Mathematical formulation of the problem leads to a linear differential equation of the second order with constant coefficients. The problem of two electric currents with resistance and self- and mutual-induction leads to an equation exactly similar ; a solution of one of these problems contains, therefore, that of the other. The mechanical problem, as being more easily followed, is worked out fully ; transformers are also dealt with. In fact, both the mechanical and the electrical engineer will get from the study of these first two chapters a great deal of information on the subject he is interested in.

There is a third chapter where more compound functions are considered. It will be remembered that in the first two chapters functions of functions are practically left out, and only the simplest and fundamental functions x^n, e^x and $\sin x$ are introduced. The author now recommends the student to supplement the knowledge so far gained by reading the ordinary treatises on the calculus ; but he gives a short outline of the results in his third and last chapter, which has the characteristic heading "Academic Exercises." But even here, in a little more than 100 pages, he goes beyond what is found in most elementary treatises ; for he introduces a good many differential equations, and even zonal harmonics and Bessel functions are touched upon. In the middle of the chapter there is a page devoted to Osborne Reynolds' "Theory of Lubrication of Journals," where the essence of Reynolds' complicated investigation is given in a marvellously simple manner.

Of course, from a purely mathematical and academic point of view, it would be easy to find fault, and perhaps to condemn, the whole work. But the book is not meant to be academic ; in fact, it is from beginning to end a protest against the academic treatment of mathematics, and as such we welcome it most heartily.

We recommend the book not only to the engineering student and to all who want to learn the calculus, but, indeed, especially to teachers of the subject, who will find many points raised in it to set them thinking, quite apart from the great variety of examples given. We also recommend it most strongly to teachers in the modern or science side of secondary schools. A careful study of the Introduction and the beginning of Chapter i. will give them many hints as to how to make mathematics attractive to those who are not gifted by nature with the ability to follow abstract reasoning, but who are often very capable of understanding things concrete. They will find also much material for home work.

If the methods here used were more generally introduced into the teaching of mathematics at school, the number of boys declared incapable of learning mathematics would, we feel sure, decrease to an astonishing degree. And indeed the same methods might probably be used in other subjects, and then the science side of secondary schools might lift its head and cease to be the refuge of those who can "neither learn classics nor mathematics." O. HENRICI.

TRAVELS IN THE INTERIOR OF SOUTH AFRICA.

The New Africa: a Journey up the Chobe and down the Okovanga Rivers: a Record of Exploration and Sport. By Aurel Schulz, M.D., and August Hammar, C.E. Pp. xii + 406. (London: Heinemann, 1897.)

THE principal title of this work can hardly be said to be quite applicable to its contents, seeing that the journey it describes was made no less than twelve years ago, before the "scramble for Africa" had reached its full height. In spite, however, of the length of time which has elapsed since the events recorded took place, there is much in Dr. Schulz's pages which well repays perusal. To the class of readers which looks chiefly for an agreeable narrative of sport and adventure, it offers abundant attractions, while those who prefer more solid matter will find scattered through it a considerable amount of information on the country passed through.

Dr. Schulz, who shortly before his journey had qualified in medicine in Berlin, set out from Natal in March 1884, accompanied by Mr. Hammar, on an exploring expedition into the remote interior of South Africa. Proceeding through the Transvaal and Khama's country to the Zambezi, the travellers next ascended the Chobe, its western tributary, to nearly 17° S. lat., and crossed over to the Kubango or Okovanga (this, and not Okavango, is Dr. Schulz's spelling), the principal feeder of Lake Ngami. This river was followed down to the lake, and Khama's country was reached on the return journey by way of the Zuga. A great part of this route led through country rendered classic by the early labours of Livingstone, and since traversed by a host of sportsmen and explorers; but a certain amount of new ground was broken in the region of the Chobe and Okovanga, and as a careful survey was made by Mr. Hammar, some real addition to our knowledge resulted from the journey.

The whole region stretching northwards from Lake Ngami is so level that the rivers form a complex network, the details of which are even now far from completely understood. The confusion is heightened by the fact that several of the streams flow in one direction, or the reverse, according to the time of year. It has long been supposed that the Okovanga sends some of its waters to the Chobe, some finding the connecting channel in the Mababe just west of 24° E. Dr. Schulz claims to have ascertained the existence of another branch of the Okovanga leading to the Chobe. The point of bifurcation was not seen, but an important channel was found to enter the Chobe from the west, and native accounts confirmed Dr. Schulz's suspicion that it came from the Okovanga. The route followed by the expedition led through a barren region of sand-belts, in which the travellers suffered from want of water. The sight of the Okovanga—a fine stream 400 yards broad, of the capabilities of which as a water-way the author expresses a high opinion—was therefore most welcome. It was struck at the town of Debabe or Indala (identical, it appears, with "Andara, or Debabe's town," reached by Green in 1856), and although its course hence to Lake Ngami had previously been explored by that traveller, Andersson and others, Dr. Schulz was able to define, more precisely than they had done, at least the western bank of the series of swamps which mark the course of the river. During this part of the journey the travellers were virtually prisoners, being taken for spies of the Matabele, and conducted under guard to Moremi, chief of the country near the lake, whose people retained no pleasant memory of a Matabele raid to which they had nearly succumbed a few years before. The lives of Dr. Schulz and his party were in some danger for a time, but were saved by the testimony of a child who had been vaccinated by the doctor at Shoshong on the way up.

The book abounds with stories of encounters with the wild animals of South Africa, and gives interesting details illustrating their habits. They were especially plentiful near the Chobe, where their numbers had not yet begun to be thinned by the persecution of sportsmen. One valley is described as having seemed a teeming mass of life, troops of every variety of game appearing to view at the same instant. Dr. Schulz has a good deal to say anent the Mosaros, a desert tribe with which he came in contact, and which he considers a fugitive branch of the Hottentots, distinct from the Bushmen proper, though often called by that name. The book is not provided with an index, but contains a map showing the features of the country along the line of route, with some information on the surface geology. Some of the illustrations give a good idea of the types of country and vegetation common in South Africa.

OUR BOOK SHELF.

Contributions to the Analysis of the Sensations. By Dr. E. Mach, Professor of the History and Theory of Inductive Science in the University of Vienna. Translated by C. M. Williams. Pp. xi + 208. (Chicago: Open Court Publishing Co., 1897.)

PROF. MACH has expressed his approval of this translation of his "Beiträge zur Analyse der Empfindungen." For the most part it has been excellently rendered into English; but occasionally there are sentences that read queerly—*e.g.* "Relatively greater permanency exhibit, first, certain complexes of colours," &c. (p. 2); "Merely its application is not complete" (p. 32); "Different is my opinion with regard to Stricker's views on language" (p. 131); "If the process is over with . . ." (p. 157).

Every one who is interested in psychophysics will welcome an examination of the sensations by a leading physicist, especially when his analysis is so suggestive and his style so delightful as Prof. Mach's. The style is greatly superior to the mode of construction of the book. It would be an exaggeration to say that it is mainly built up of footnotes; but there are three prefaces, two